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ABSTRACT

A unit on animals was taught to 64 preschool children (44 in an experimental group and 20 in a control group). Children in the experimental group were taught nine major concepts over four levels of abstraction (designated as superordinate, intermediate, subordinate, or particular levels). Each concept was presented by means of an advance organizer followed by related activities. The order of presentation was sequenced in a hierarchical manner with superordinate concepts being taught first and particular concepts being taught last. Animal concepts were also taught to the control group, but advance organizers were not employed and concepts were introduced primarily at the particular level. Over a 10-week period five concept tests were administered to all 64 children. Tests were composed of four subtests designed to measure concept attainment at four levels of generality. Results indicated that children in the experimental group, as compared to those in the control group, obtained significantly higher performance scores on 14 out of 15 subtests and showed significant score increases from the first to the fifth test on all four levels of concept generality. (Author/MP)

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Preschool Children's Learning of Concepts at Four Levels of Abstraction

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Footnote

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Preschool Children's Learning of Concepts

at Four Levels of Abstraction

Abstract

A unit on animals was taught to 64 preschool children. Forty four experimental children were taught nine major concepts over four levels of abstraction designated as superordinate, intermediate, subordinate, and particular levels. Each concept was presented by means of an advance organizer followed by related activities. The order of presentation was sequenced in a hierarchical manner with superordinate concepts being taught first and particular concepts, last. Animal concepts were also taught to 20 control children but advance organizers were not employed and concepts were introduced primarily at the particular level. Five concept tests were administered to all 64 children over a ten week period. Tests were comprised of four subtests designed to measure concept attainment at four levels of generality.

Results indicated that experimental chidlren, compared to control children, obtained significantly higher performance scores on 14 out of 15 subtests and significant score increases from Test 1 to Test 5 at all four levels of concept generality. Repeated measures analysis showed significant main effects due to condition at all levels of generality at each time of testing. Pair wise contrasts indicated that experimental children retained high level concepts at a somewhat constant level whereas significant losses of low level concepts were sustained providing some support for the process of progressive differentiation.

Preschool Children's Learning of Concepts

at Four Levels of Abstraction

An important aspect of Ausubel's learning theory (Ausubel, Novak, & Hanesian, 1978) is the process of assimilation. Ausubel has suggested that the learning of a hierarchy of super and subordinate concepts should begin with the learning of superordinate concepts followed by the subsequent learning of related subordinate concepts and factual information. In this learning sequence when new knowledge (as subordinate concepts or factual information) is learned, it can be assimilated or subsumed by relevant general ideas (superordinate concepts) already present in cognitive structure. When assimilation of new knowledge occurs by subsumption, knowledge at both the super and subordinate level is modified (Ausubel et al., 1978, p. 125).

An important aspect of this modification is that superordinate concepts become more clearly differentiated and tend to remain longer in memory while related subordinate concepts and factual information tend to have less salience in memory--indeed, some of this less inclusive information may be forgotten. The process of differentiating superordinate concepts is probably best described as follows. Related subordinate concepts can at first be identified by the recognition that they possess a property, or properties, that define the superordinate class. The subordinate concepts then need to be learned separately in terms, not only of the properties defining the general class into which they belong, but also their particular defining properties.

The process of learning related subordinate concepts has the effect of clarifying in memory the property, or properties, they share and which define the superordinate concept as well as those properties that uniquely define each subordinate concept. According to Ausubel, it is the general

properties that tend to be remembered longest rather than the instances of subordinate concepts and facts from which they were extracted. For example, the identifying properties of the concept mammal are hair or fur on the body, the conception of a fetus in utero, and the birth of an infant via a birth canal, and the presence of mammary glands in the female which provide milk to be suckled by the infant for a period after birth. These general properties can be observed in land-based animals, in water-based mammals, and in flying mammals. It is these properties that are important for the identification of mammal rather than the knowledge of subordinate concepts that define particular sub-groups and species of mammal.

In organizing concepts into a hierarchy, it is important to differentiate their hierarchical level by the properties that define a concept or concepts at each level of abstraction. Criteria for identifying concepts at two levels of generality in a hierarchy have been suggested by Rosch and her colleagues (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). At the superordinate level, the most general defining properties are used with exemplars being, relatively speaking, very diverse. For example, musical instruments are objects that can be blown into, hit, plucked, and stroked to make musical sounds. They include such diverse examples as a trumpet, drum, piano, guitar, harp, and violin. At the subordinate level exemplars of concepts are more similar to each other. For example, there are different sizes of saxaphone, but except for the straight soprano saxophone, all other saxophones have a clearly defining S shape and key arrangement.

Although Rosch et al. (1976) mention only two levels of generality in concept hierarchies, it seems likely that continuum of levels might possibly be defined (e.g., Lawton & Wanska, 1979), the number of levels

being determined at least in part by the relative abstract complexity of concepts in particular hierarchies.

Ausubel contends that, to promote subsumption learning, the teacher should first present superordinate concepts in an advance organizer (AO) lesson. In other words, the superordinate concepts are presented in advance of related subordinate concepts and factual information so as to organize cognitive structure for subsequent, subsumption learning (Ausubel et al., 1978, pp. 173-173). It should be added that, apart from the most superordinate concepts, concepts at various levels in a continuum are superordinate to the less general levels below them and subordinate to the more general levels above them in the hierarchy.

Since it would be difficult, if not impossible, to teach at one time all the concepts in a hierarchy, it has been suggested that "units" of learning be organized for each successive level in whatever continuum exists from most to least general level, each level being introduced by an AO lesson. Such a series of AO lessons would, itself, form a hierarchy (Ausubel et al., 1978, pp. 191-192). Each successive AO would be assimilable to preceeding AOs and, at the same time, be preparing the learner for the subsequent learning of new concepts at a more particular level. It has been shown that such comparative AOs tend to show greater facilitative effects on learning than expository organizers (Kozlow & White, 1980).

Previous studies have shown that AO lessons can be used successfully to promote the assimilative learning and retention of related subordinate concepts and factual information for college students (Kuhn & Novak, 1970, 1971; Weisberg, 1970), elementary grade children (Gagne & Weigand, 1970; Hibbard, 1971); and preschool children (Blue-Swadener & Lawton, 1972; Lawton & Fowell, 1977; Lawton, Hooper, Saunders, & Roth, 1978; Lawton,

1982).

Although the latter four studies involved the use of a series of sequentially organized advance organizers, no attempt was made to measure, in particular, the progressive differentiation of concepts at increasingly more particular levels. However, the evidence from these studies strongly suggests that this type of assimilative learning did occur under such conditions of AO presentation. In the present study, we examined children's progressive differentiation of super- and subordinate concepts during the assimilative process of learning a hierarchy, of natural science concepts focusing on animals.

Animal concepts were identified at four levels of abstraction: (1) Level one (superordinate)--all things are either living or not living; (2) Level two (intermediate)--living things include plants and animals; (3) Level three (subordinate)--almost all animals belong to one of the following classes: mammals, birds, fish, reptiles, amphibians, and arthropods; and (4) Level four (particular)--each class of animals can be exemplified by particular species. For example, dogs, bears, foxes (mammals living on land); whales, porpoises (mammals living in water); and bats (flying mammals). Each concept was presented individually in a related series of AO lessons. The format used to construct each AO lesson will be described in the "Methods" section.

It was hypothesized that: (1) AO lessons would result in superior performance by the experimental children on all tasks; (2) Increased differentiation of superordinate concepts would occur as instruction progressed, that is, that following the introduction of the most superordinate concept, a more accurate and complete differentiation of this concept would occur over time as the children were exposed first to intermediate, then subordinate, and, finally, particular concepts; and (3)

Following completion of instruction, children's retention in memory of learned information would be best for the concepts at the superordinate level (living and non-living things) and would diminish as a function of the decreasing inclusiveness of concepts (levels 2-4).

Method

Subjects

Subjects were 64 middle-class, rural children (38 boys, 26 girls) drawn from three preschools. Children from two preschools comprised the experimental group with children from the third preschool comprising the control group. Experimental group children were, on average, 4 years, 9 months of age (range: 4 years, 2 months to 6 years, 2 months) and had a mean mental age (as measured by the Peabody Picture Vocabulary Test) of 6 years, 2 months (range: 3 years, 11 months to 8 years, 1 month). Control group children were, on average, 4 years, 8 months of age (range: 3 years, 10 months to 5 years, 4 months) with a mean MA of 6 years, 2 months (range: 3 years, 11 months to 7 years, 6 months).

Instructional Materials

Head teachers from all three preschools agreed upon a set of concepts to be used as the basis of a unit on animals. Selected concepts pertained to the following six classes of animals: mammals, birds, fish, reptiles, amphibians, and arthropods. It was agreed that the animal classes would be introduced in the sequence just named, and that a plant unit would be taught prior to the animal unit. The latter requirement was made in order to prevent any particular group from having an initial advantage over other groups with regard to prior knowledge about living things. The content of the units was, therefore, essentially the same for E and C

groups.

Natural science concepts for the E group were organized at four levels of generality, superordinate, intermediate, subordinate, and particular. This hierarchy of concepts is illustrated in Figure 1. The concepts of Living Things and Animals were presented in the first two AO lessons. The idea that most animals belong to one of six groups was provided in the third AO lesson and the concepts of Mammals, Birds, Fish, Reptile, Amphibian, and Arthropod in six successive AOs. This organization of instruction provided a sequence of nine AO lessons in a hierarchy with three levels of generality. Information at the fourth level of generality (particular) was in the form of particular examples of each class of animal and was presented in related learning activities following each AO at the subordinate level, AO's four through nine. Related learning activities are described in the following section. The teacher of the control group was asked to organize the six concepts in the way she usually organized learning materials. This resulted in a series of lessons pertaining to the six classes of animals. Each class, except one, was presented in terms of two or more subsets as follows: Mammals, farm and wild; Birds, winter and summer; Fish, aquarium and ocean; Reptiles, past and present, Amphibians (no subsets); and Arthropods, 6 legs, 8 legs, and 10 legs.

Insert Figure 1 about here

Instructional Methods

Children in both E and C groups received 20-30 minutes of instruction twice a week for eight weeks. Teachers indicated they were satisfied that

they had completed what they considerd to be sufficient instruction within this time period.

Teachers of the E group children were trained to teach the natural science concepts at the four levels of generality using AO lessons followed by "related activities" (RA) in the order indicated in Figure 1. Space will permit only a brief description here of an AO-RA lesson dealing with the animal class of mammal. This is followed by a description of a control group lesson.

The teacher and five children assembed on a rug beneath a large bulletin board. Displayed upon the bulletin board was a hierarchy of animal concepts. The words "living" and "not living" were shown at the top with living subdivided into "plants" and "animals" and animals further subdivided into six classes. Real objects and pictures had been placed with the labels "living" and "animals". These exemplars illustrated the properties of the concepts of living things and of animals and were intended to remind the children of these properties.

Pointing to appropriate parts of the display, the teacher began the AO by briefly reviewing these concepts and remainding the children that "last time" they learned that most living animals belong to one of six classes. Today they would learn more about the mammal class. She then provided an attribute for the class of mammals saying, "Mammals have fur or hair". A furry dog face, made from synthetic fur with felt features was passed around. A picture of a mother cat nursing kittens was also passed with the explanation that mammals are living animals whose babies drink milk from the mother's bodies. Some discussion about the latter followed after which the teacher told a short story about a little boy who wanted to find the mammals in his home. The teacher illustrated the story with pictures on a flannel board.

After the attributes of living mammals had been verbally presented, exemplified by means of objects and pictures, and further illustrated by means of the brief story, related activities provided the children with "hands-on" experiences and considerable detail about the concept of mammals. The RA's provided were:

a) A furry bunny could be made by gluing cotton balls onto a predrawn rabbit picture.

b) A flannel board showing grass, water, and air (clouds) was provided along with a box of pictures depicting land mammals (e.g., cow, human, chimpanzee, lion); sea mammals (e.g., whale, dolphin); and air mammals (e.g., bats). Children matched mammals to the appropriate habitat.

c) A matching game involving the use of two-piece puzzles required the child to match infant mammals to mother mammals.

d) Five sets of pictures each comprised of three living mammals and one non-living mammal (e.g., rocking horse) or "other" animal (e.g., a bird or fish). Child placed paper X on the mismatched picture in each set.

While the children interacted with these materials, the teacher observed carefully and asked questions of individual children designed to test and expand the children's knowledge of mammals such as "Is the teddy bear a living mammal?", and "Do you know of other mammals which might live on land?".

Once introduced, most of these activities were moved into the larger classroom for optional use during free play, or, if needed, a second instructional session was devoted to the same topic to provide additional time (practice) for activities.

A control group lesson proceeded as follows. In this example, the

lesson topic was eight-legged arthropods. The children had previously studied bees and ants (six-legged arthropods or insects). The teacher employed the word arthropod when introducing the new topic, but primarily focused upon the label "spider". Pictures of spiders and spider webs from nature books were shown. Characteristics of spiders such as habitat, egg birth, and source of food was discussed. The spider's eight legs were counted from several pictures and conversation about the children's experiences with spiders was encouraged. After a period of animated talk, the teacher read "Be Nice to Spiders" by Margaret Bloy Graham, and the fingerplay, The Eensy Weensy Spider, was twice run through.

Thereafter the group of six to ten children was divided into two smaller groups. One group was allowed to paint pictures of a spider web and a spider while the second group participated in free choice activities in the larger classroom area. Care was taken to paint four legs on one side of the spider's body and four on the other with most of the children succeeding in this task. Pictures of spiders and the book, "Be Nice to Spiders", were left out for the children to peruse during free play. Additional spider pictures could be painted if desired. Shortly before the children left preschool, they reconvened and again spoke of spiders which are arthropods, have eight legs, and spin webs.

The emphasis in teaching AO lessons was to focus children's attention on the properties of concepts. For example, "mammals are living animals with fur or hair on their bodies, and the babies, when they are first born, drink their mother's milk". During RAs children were encouraged to identify animals having these properties from amongst animals and other objects that did not possess these properties. Thus each AO lesson helped to differentiate the concept of animal (and animal as a living thing since there were examples of non-animals and non-living things to discriminate

from) and each RA helped to differentiate the class of animal in question.

The control group teacher was encouraged to use her usual teaching method. It was observed that this teacher did not differentiate super- and subordinate concepts in her teaching. Instruction focused on factual information with some reference to the concept categories and concept labels. It was also observed that both E group teachers followed the hierarchical sequence of AO instructions using an acceptable teaching procedure. Since teachers were unaware of the distinction between teaching methods for E and C group children, each participated with equal enthusiasm in the experiment, reducing the possibility of a "Hawthorne" learning effect for some children.

Test Materials and Scoring Procedure

A battery of five investigator-designed animal concept tests was administered to each subject. Test 1, a pretest, was administered before teaching commenced. This test was administered to ascertain the children's level of naivete regarding the subject matter to be taught. Test 2, the initial posttest, was administered during the third week of instruction with Test 3 and Test 4 being given during the 5th and 7th weeks, respectively. The final posttest, Test 5, was administered after the eight week instruction period was concluded.

All tests, with the exception of Test 2, consisted of four classification tasks, one each at the four levels of concept generality. Test 2, administered at the conclusion of the third week of an eight week instruction period, contained only three tasks. Testing materials and scoring procedure were as follows:

Tests 1 and 5

Task One: Twelve green picture cards displaying simple line drawings, 7 of living things, and 5 of non-living things. Child sorted pictures into two groups--living and non-living.

Task Two: Twelve white picture cards with line drawings showing 6 animals, 3 plants, and 3 non-living objects and a set of 13 rubber jar rings. Child played Find the Animals by placing rubber rings upon pictures of living animals.

Task Three: A set of 11 "two-piece puzzles" each consisting of one white piece and one blue piece. White pieces had line drawings depicting attributes of animal classes and blue pieces depicted the various animal classes by means of symbols. Thus white attribute pictures could be matched with blue animal class symbols. Child matched two-piece puzzles by placing together one blue class-symbol card and one white card illustrating an appropriate class attribute.

Task Four: A set of 14 animal pictures, including at least 2 from each of the 6 animal classes, and 6 white cards each depicting a symbol of one of the 6 animal classes. Child matched each picture of a specific animal to one of six class-symbol cards.

Test 2

Task One: Nine yellow picture cards with red line drawings, 5 of living things and 4 of non-living objects, and a set of 12 blue poker chips. Child placed blue plastic chips upon the pictures of living things.

Task Two: Three sets of cards with simple line drawings as follows: a set of 6 small white cards displaying identical giraffes representing "animal"; a set of 4 small white cards displaying identical evergreen trees representing "plant"; and a set of orange cards, 4 depicting animals, 2

plants, and 2 non-living objects. Child placed "plant" cards beside pictures of plants and "animal" cards beside pictures of living animals.

Task Three: Eight red cards with simple line drawings. The drawings illustrated a variety of animals, among them 4 mammals. Child sorted animal pictures into two groups--mammal and non-mammal.

Test 3

Task One: Nine pictures cut from magazines, 5 displaying living things, and 4, non-living things. Child sorted pictures into two groups--living and non-living.

Task Two: Eight pink cards with purple line drawings: 3 plants, 3 animals, and 2 objects. Also, one box of large brown buttons and one box of large green buttons. Child played the Button Game by placing brown buttons on pictures of living animals and green buttons on pictures of plants.

Task Three: Seven coral colored cards with green line drawings illustrating attributes of 3 animal classes (the first 3 in the sequence of 6 to be studied) and 3 white symbol cards, each one representing one of the following animal classes: mammal, bird, and fish. Child matched each colored attribute card to one of three white class-symbol cards.

Task Four: The same white animal class symbol cards used in task three and a set of 10 small toy animals: 5 mammals, 3 birds, and 2 fish. Child placed each toy animal with one of three white class-symbol cards.

Test 4

Task One: A set of dark green picture cards with simple line drawings, 6 of living things and 4 of non-living things; and a box of large metal washers. Child played Find the Living Things by placing metal

washer upon pictures of living things.

Task Two: Seven magazine pictures, 4 of animals, and 3 of plants; one giraffe "animal" card and one evergreen tree "plant" card also used in Test 2, Task Two. Child sorted pictures into two groups, placing pictures of animals with the "animal" card and pictures of plants with the "plant" card.

Task Three: A set of seven medium-blue cards with purple line drawings each illustrating an attribute of one of the 5 following animal classes--mammal, bird, fish, reptile, and amphibian; a set of berry boxes; and a set of white animal class symbol cards, one each representing the mammal, bird, fish, reptile, and amphibian classes. Child played the Berry Box Game by sorting colored attribute cards into one of five berry boxes each marked with a class symbol.

Task Four: Ten light green cards with simple line drawings of animals belonging to the first 5 of the 6 animal classes studied during the treatment period and the same set of white animal class symbol cards used in Task Three. Child matched each picture of a specific animal to one of five class symbol cards.

All pictures, both drawn and printed, were chosen because they clearly exemplified properties of the concept being tested. For example, at level two (living things include plants and animals; animals can be distinguished from plants), animals pictured might be hatching from eggs, eating and drinking, or moving about on their own as in swimming or flying.

Verbal as well as overt behavior was scored since, for each task, the child was asked to justify each response. Test 2, task 1, for example, required the child to place a blue chip on each picture of a living thing. Placement behavior was scored by allowing one point for every picture of a plant or animal marked with a chip. In addition, the child was asked to

explain each placement of the chips, e.g., "How did you know these were living things?". It was anticipated that a child might mention growth, making new ones of its own kind, or the need to eat or drink. The child was encouraged to think of at least three explanations and a point was allowed for any valid attribute of living things up to a total of three. All other tasks were scored similarly.

Because the number of concepts to be tested increased as the treatment period progressed, the raw-score scale range differed from test to test. Tests 1 and 5 had a maximum score of 50 points, Test 2 had 21 points, Test 3 had 37 points, and Test 4, 43 points. Raw scores were converted to percentages for purposes of comparison. Thirty-nine percent of protocols from each of five times of testing were also scored by an impartial judge with no knowledge of the study. Correlations between scoring by the first author and this judge ranged from .99 to 1.00.

The average test reliability across five times of testing computed using Horst's modification of the Kuder-Richardson Formula 20 for tests with test items varying in level of difficulty yielded an r of .68.

Testing Procedure

All children were tested individually under similar conditions. Two testers were employed. One tested children at the control group preschool and the experimental group 2 preschool. The second tested children at the experimental group 1 preschool. Both testers were former teachers who displayed obvious rapport with the children in this study. Each task was explained to the child according to a set protocol to maintain reliability of task presentation. Order of tasks within each test was randomized. The tester first explained to the child the content of each picture in the task being attempted. For example, "This is a picture of a father penguin, a

mother penguin, and their new baby penguin" (from a Level One task--living things make new ones of their own kind); "This is a picture of a big fish that has caught a little fish for food." (from a Level Two task--animals find their own food); "This is a picture of a feather." (from a Level Three task--only birds have feathers; and "This is a picture of a turtle." (from a Level Four task--specific example of an animal belonging to the reptile class). The tester then explained how the pictures were to be used to "play the game".

RESULTS

Raw scores for each test were transformed to percentages of total possible scores to provide a single scale criterion for all tests. Means and standard deviations at each of four levels of generality at five times of testing are shown in Table 1. Because an analysis of post test scores revealed that no significant differences were found between experimental group mean scores for Test 2 through Test 5 at any level of generality, the two experimental groups were collapsed (as shown in Table 1) for all further data analysis. No significant differences in performance between groups on the pretest appeared at the superordinate, intermediate, and subordinate levels although a t-test indicated significant differences at the particular level favoring the control group ($p < .05$).

Insert Table 1 about here

T-tests indicated that significant gains were made by experimental children from Test 1 to Test 5 at every level of concept generality (see Table 2). Further t-test analysis compared treatment group performance at each of four levels of concept generality for Tests 2 through 5. Results

are shown in Table 3. Fourteen out of 15 comparisons indicate significantly superior performance in favor of the experimental group children.

Insert Tables 2 and 3 about here

A condition (2) x level of concept generality (4) x time of testing (3) repeated measures ANOVA was performed on the posttest data. Because Test 2 lacked a separate test of subordinate level concepts, this test was, of necessity, omitted from the ANOVA analysis. The results are indicated in Table 4, showing significant main effects due to condition for each of four levels of concept generality at each of four times of testing. Interaction effects were not significant.

Insert Table 4 about here

In order to determine the source of the differences, three pairwise contrasts were examined at every level of concept generality and within each treatment group. These contrasts, reported in Table 5, indicate that (a) following the improvement in performance at Time 2 of testing, no significant gains or losses of superordinate concepts were made by experimental children over time; (b) at the intermediate level, an improvement in performance occurred at Time 4 of testing and was sustained at Time 5; and (c) significant losses of memory of subordinate concepts and particular information did occur over time.

Insert Table 5 about here

The control group children's performance did improve at Time 5 of testing in connection with concepts at the superordinate level. This was also the case for the performance of these children on intermediate level concepts at Time 4 of testing, though it was followed by a a significant loss at Time 5. As we can see from Table 5, a loss in performance for subordinate and particular concepts occurred at Time 4 of testing and was sustained at Time 5.

In summary, these results provide information about the efficacy of the advance organizer instruction, progressive differentiation in the learning of concepts presented at successive levels of generality from super to subordinate levels, and the extent of retention of concepts at four levels of generality.

Discussion

The results can be discussed with reference to the hypotheses mentioned earlier. First, the expectation that the experimental group performance would exceed control group performance at each level of concept generality was realized since experimental children obtained significantly higher scores on 14 out of 15 subtests when compared to control children (hypothesis 1). The experimental group also made significant score increases from Test 1 to Test 5 at each level of concept generality whereas no overall gains were made by the control group.

Second, data revealed that E group children retained intermediate concepts somewhat better than superordinate concepts and particular information somewhat better than subordinate concepts. However, the fact that superordinate and intermediate concepts were retained at a fairly constant level while there was a marked forgetting of subordinate concepts and particular information over time provides some support for the

expectations that (a) progressive differentiation of superordinate concepts did occur according to the sequence of instruction (hypothesis 2), and (b) abstract concepts are more likely to be retained in memory over time whereas forgetting of related and more detailed information tends to increase as a function of decreasing inclusiveness (hypothesis 3).

It must be recognized, however, that support for the expectation that, over time, concepts at higher levels of generality are retained longer in memory than related concepts at a less inclusive level, or related particular information, is not cut and dried. For one thing, children remembered information at the particular level (level 4) quite well. This may be due to a recency effect in learning since the final test (Test 5) was administered shortly following completion of instruction. Had time permitted, it would have been very useful to conduct a series of delayed posttests in an attempt to measure, more effectively, the process of remembering and forgetting over a lengthy period of time. It might be expected that this procedure would have resulted in the detection of a diminished recency effect and provided a better indication of longevity in memory of concepts at levels 1 and 2.

We must also consider the fact that children in both treatment groups seemed to find it easier to remember concepts at the superordinate and intermediate levels at each time of testing. With respect to taxonomies of concrete objects, Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976), have found that "basic level" labels are most easily perceived and first named. The "basic level" is the most inclusive level of classification at which objects have most attributes in common. Car, for example, is a basic level object as opposed to vehicle at the superordinate level or station wagon at a lower level of abstraction. Nonetheless, the classification of living things is such that the use of labels like

"living thing", and especially "animal", and "plant", are apparently a familiar facet of the young child's daily existence. Many of the children in this present study, when initially tested, were able to discriminate a living creature from a non-living object and a plant from an animal. It was apparent from test protocols that, initially, for all children such discrimination may well have been a case of the right answer for the wrong reason. An insect may be classed as a living thing rather than a non-living object because it is "squashable". A monkey, rather than a daisy, may be placed in the animal group because it has eyes. Some children appear to have an intuitive understanding of these concepts without fully understanding the properties that define the concepts or the hierarchical structure of concepts of which they are a part. This intuitive level of understanding may have resulted in the children of the present study achieving a higher degree of accuracy in identifying living things, animals, and plants, without being able to differentiate the defining properties of these concepts, thus explaining the initial high scores at the super- and intermediate level of concept generality. Data indicates that, as the study progressed, this remained the case for the control children but not for the experimental children.

Although children in general performed better on superordinate and intermediate level concepts throughout the sequence of testing, this fact provides only part of the performance picture. It also needs to be emphasized that patterns of performance on concepts at the four levels of abstraction were different for the E and C groups across time. The widest gaps in performance between the two groups following each phase of instruction, favoring improvement by the E group, are at the subordinate and particular levels (an average difference of 25% and 27%, respectively). This indicates a substantial progressive differentiation

of concepts for the E group compared to the C group. Indeed, by time five of testing, whereas the E group had significantly improved on their pretest performance at all levels of generality, the C group showed no improvement at the superordinate, intermediate, and subordinate levels and a significant loss at the particular level (Tables 1 and 2). The question of whether the experimental group might also have demonstrated superior long-term retention, especially of level 1 and level 2 concepts, cannot be addressed within the limitations of this study.

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Table 1

Means and Standard Deviations at each of Four Levels of Concept Generality at Five Times of Testing.

Test	Sub-Test	E-Group (N = 44)	C-Group (N = 20)
Test 1	Superordinate	56.7(17.5)	53.0(17.2)
	Intermediate	52.2 (6.9)	53.5 (6.1)
	Subordinate	18.6(13.0)	22.7(13.0)
	Particular	21.4(15.1)	32.3(13.0)
Test 2	Superordinate	70.0(19.2)	45.3(26.2)
	Intermediate	61.0(10.9)	49.3(17.0)
	Particular	60.6(17.3)	29.2(17.0)
Test 3	Superordinate	73.4(16.7)	54.1(20.0)
	Intermediate	58.0(13.4)	46.7(19.0)
	Subordinate	76.4(25.1)	50.5(25.4)
	Particular	69.1(16.0)	44.2(16.9)
Test 4	Superordinate	66.2(23.6)	47.5(35.3)
	Intermediate	64.8(12.1)	61.4(12.4)
	Subordinate	56.8(23.5)	31.0(19.6)
	Particular	56.7(19.4)	30.3(14.7)
Test 5	Superordinate	71.6(17.5)	62.3(14.2)
	Intermediate	56.6(16.6)	45.5(16.4)
	Subordinate	45.5(26.2)	21.7(12.6)
	Particular	53.6(23.5)	23.2(13.7)

(a) SD's are in parentheses.
(b) Means are given at percentages of total possible points.

Table 2

T-tests on Subtest Percent Means
Between Test 1 and Test 5

Group	Superordinate	Intermediate	Subordinate	Particular
Control	.086	.056	.754	.030*(1)
Combined Experimental	.000**	.031*	.000**	.000**

(1) A significant loss
* p<.05
** p<.01

Table 3

P Values for T-tests comparing E and C Group
Subtest Percent Means

Subtest	Test 2	Test 3	Test 4	Test 5
Superordinate	.000**	.000**	.015*	.041*
Intermediate	.001**	.008**	.312	.005**
Subordinate	---	.000**	.000**	.000**
Particular	.000**	.000**	.000**	.000**

* p .05 in favor of E group.
** p .01 in favor of E group.
Df in each case was 62.

Table 4

Analysis of Variance with Repeated Measures

Variable	Source		df	MS	F	P
Superordinate Concepts Tests 3, 4, & 5	between	63				
	treatment groups		1	1.0292	12.6617	.001
	error		62	.0813		
	within	128				
	measures		2	.1461	5.3466	.006
	interaction		2	.0431	1.5788	.210
	error		124	.0273		
Intermediate Concepts Tests 3, 4, & 5	between	63				
	treatment groups		1	.3534	10.9117	.002
	error		62	.0324		
	within	128				
	measures		2	.2173	12.9917	.006
	interaction		2	.0372	2.2212	.113
	error		124	.0167		
Subordinate Concepts Tests 3, 4, & 5	between	63				
	treatment groups		1	2.6127	23.4921	.000
	error		62	.1112		
	within	128				
	measures		2	1.2622	46.0714	.000
	interaction		2	.0018	.0644	.938
	error		124	.0274		
Particular Concepts Tests 3, 4, & 5	between	63				
	treatment groups		1	3.0562	42.0727	.000
	error		62	.0726		
	within	128				
	measures		2	.4868	31.7996	.000
	interaction		2	.0117	.7629	.468
	error		124	.0153		

Table 5

Pair-wise t-test comparisons of performance at times 3, 4, and 5 of testing with indications of gain and loss.

				T-Values and Gain/Loss Indication			
Group	N	df	Contrasts	Superordinate	Intermediate	Subordinate	Particular
E	44	86	T 3 vs 5	0.53	0.25	8.74*(L)	5.83*(L)
			T 3 vs 4	2.07	2.47*(G)	5.54*(L)	4.65*(L)
			T 4 vs 5	1.54	2.22	2.13*(L)	1.18
C	20	38	T 3 vs 5	1.57	0.29	5.51*(L)	5.39*(L)
			T 3 vs 4	1.26	3.60*(G)	3.72*(L)	3.56*(L)
			T 4 vs 5	2.82*(G)	3.89*(L)	1.79	1.83

* Value indicates significance, Dunn t, .05 level
(G) = Gain
(L) = Loss

Figure 1

Concepts at Four Levels of Generality

Level One - Superordinate

Living Things	Non-Living Things
grow make new ones of their own kind need food & water	

Level Two - Intermediate

Plants	Animals
usually grow from seed stay in one place make own food	live or egg birth move about on their own find food & water

Level Three - Subordinate

Mammals	Birds	Fish	Reptile	Amphibian	Arthropod
fur or hair mother's milk	feathers	fins gills scales	scales - lays eggs on land	2 lives: infant in water adult - land or water	more than 4 legs

Level Four - Particular

specific animals belonging to each class